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13. ABSTRACT (Maximum 200 words)

The acquired instrumentation has established new research capabilities and approaches for the recording and analysis of biological neural network activity in the mammalian brain. The many-neuron recording system acquired through this funding will support the simultaneous detection, amplification, filtering, A/D digitization, isolation, and recording of large groups (50-150) neurons in the brains of behaving animals. This ability will improve by an order of magnitude our efficiency in data collection and will advance our capabilities from the level of single cell analysis to that of neural ensembles believed to be the functional units of information processing in cortical areas of the brain. Such a capacity will afford an understanding of the activity of neural networks associated with behavior, improving our understanding of biological information processing for applications to Navy requirements.

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Final Technical Report

Recording and Analysis of Biological Neural Networks

N00014-97-1-0262

PI: Howard Eichenbaum

The aim of this project was to acquire instrumentation that will establish new research capabilities and approaches for the recording and analysis of biological neural network activity in the mammalian brain, and specifically improve our understanding of sensory and cognitive processing.

The many neuron recording system under development will support the simultaneous detection, amplification, filtering, analog to digital conversion, isolation, and recording of large groups (50-150) neurons in the brains of behaving animals. This ability will improve by an order of magnitude our efficiency in data collection and will advance our capabilities from the level of single cell analysis to that of neural ensembles believed to be the functional units of information processing in cortical areas of the brain. Such a capacity will afford an understanding of the activity of neural networks associated with behavior, improving our understanding of biological information processing for applications to Navy requirements.

The data acquisition system we have developed is designed to record from 16 tetrodes (64 channels) simultaneously at up to 32kHz per channel. As currently configured, approximately 20,000 waveforms per second can be captured and logged to disk. A major advantage of this system is that it is comprised of a single unit that is a completely compatible replacement for 7 Enhanced Discovery System nodes from Data Wave Technologies. Its compact system format also offers a substantial saving in overall systems cost.

The system is compatible with Datawave Technologies Enhanced Discovery System in several ways. Our system can read and emulate the timestamp synchronization signals used by the Discovery System, so that our investment in experimental control programs for the Discovery System can also be used to control our new system. The new system simply acts as a super slave node. The system's file format is compatible the Discovery System's, so our analysis programs can be applied to data from the new system.

The system itself is composed of a standard personal computer plus three Data Acquisition Processors (DAP 3200/415a) acquired from Microstar Laboratories, Inc. (Bellevue, Washington). These DAP cards are uniquely suited to this data acquisition application for several reasons. First, each card has a stand-alone microprocessor with 4 MB of RAM that can be flexibly programmed to trigger on individual waveforms or a group of waveforms. Second, each card can perform analog to digital conversion, digital to analog conversion, and digital signal (TTL) input-output in an integrated manner and with a timing resolution of 3 microseconds. Third, multiple cards can be synchronized within single computer so that the total number of channels in the system is upwardly and downwardly scaleable with the number of data acquisition cards.

To log the data at these rates, the system uses the new Ultra-ATA IDE harddrive standard. A 6.4 GB Ultra-ATA drive is adequate to store data at the collection specifications for over an hour. Also included in the system are two 32-channel very high gain amplifiers (gains in eight steps from 2500x to 160,000x) with integrated signal filters for capturing a range of biological data (High-pass filters from 0.1-1200Hz and Low-pass filters from 30-12000Hz, both in eight steps). Finally there are two 32-channel unity gain FET headstages for impedance reduction of recorded activity.